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REPORT OF MECHANICAL INTEGRITY OF INJECTION WELL #1-12

ENVIRONMENTAL GEO-TECHNOLOGIES, LLC

Romulus, Michigan

PROJECT NO.: 50909A

SEPTEMBER 2016

Prepared By:

WSP | PARSONS BRINCKERHOFF
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1.0 INTRODUCTION

In accordance with the United States Environmental Protection Agency's (U.S. EPA), requirements for the Class I UIC permit number MI-163-1W-CO10 granted to Environmental Geo-Technologies, LLC (EGT) and with the State of Michigan permit number M-452, an annulus pressure test, temperature survey, radioactive tracer and ambient pressure test was needed to be run on Well #1-12 to demonstrate the mechanical integrity of the well.

The mechanical integrity tests (MITs) are designed to demonstrate that (1) "there is no significant leak in the casing, tubing or packer" and (2) "the cement at the top of the injection interval has integrity." The test procedures to perform mechanical integrity tests were reviewed and approved by the U.S. EPA and the Michigan Department of Environmental Quality (MDEQ) prior to initiating the fieldwork.

In addition to the mechanical integrity tests, a temperature survey and ambient pressure test was run on Well #1-12 to assist in evaluating the injection zone and formation condition.

2.0 SUMMARY OF RESULTS

An annulus pressure test (APT) was performed on July 25, 2016 to demonstrate that there is no significant leak in the tubing, casing or packer. The fluid-filled annulus was pressurized to 973-psi for one (1) hour. There was a 1 psi raise in pressure for the duration of the test. This constitutes a successful pressure test with a 0.1% change in pressure.

A temperature survey (TS) was run on July 25, 2016 from surface to 4510 feet. The survey displayed no indication of a loss of external mechanical integrity and did not display any signs of upward fluid movement into unpermitted formations.

A Radioactive Tracer Survey (RTS) was run on August 8, 2016 to test the bottom hole cement. The RTS survey confirmed the leak-free condition of the tubing within the test interval as well as depicting that all injected fluids exited the injection tubing below the packer and moved out into the injection zone. The RTS further verified that the cement at the top of the injection interval has integrity and there is no upward migration of injection fluids around the casing shoe.

Ambient pressure monitoring was performed on August 9th and August 10th 2016. The results are summarized below.

- Time to radial flow: 0.24 hours following shut-in.
- Permeability: 167 md
- Skin factor: 41
- Pressure loss: 229 psi
- Flow efficiently: 0.17

3.0 ANNULUS PRESSURE TESTING

The APT was performed on Well #1-12 on July 25, 2016. This test was performed to confirm the integrity of the injection string, long string casing, the wellhead and the packer.

3.1 Annulus Pressure Test Procedures

The procedures for the APT were submitted to the EPA and can be found in Appendix A of this report. The procedures involve the pressuring up of the annulus and should be monitored for one (1) hour. Pressures should be monitored and recorded on ten (10) minute intervals for the entire hour test.

3.2 Annulus Pressure Test Results

The annulus pressure test on Well 1-12 was pressured up on July 25, 2016 to 973 psi and stabilized at 0845. The pressure was monitored by an APG Digital Model PG 3000; serial number Z3339, (0-2000 psi) gauge that was calibrated on February 22, 2016. During the one (1) hour test the total change of pressure was a rise of one (1) psi to 974 psi. This change of one (1) psi represents a pressure change of 0.1% psi, the allowable change of 3% (29.19). This test demonstrates mechanical integrity.

The test was witnessed by Jack Lanigan of MDEQ, John Frost of EGT and Rich Schildhouse of PB. The MDEQ report as well as the gauge calibration certificate are included in Appendix D.

4.0 TEMPERATURE SURVEY

In response to a regulatory requirement, a temperature survey was run on July 25, 2016 on Well #1-12. The purpose of the requirement is to insure that there is no evidence of any upward movement of fluid that may travel toward the Underground Source of Drinking Water (USDW).

4.1 Temperature Survey Procedures

The procedures for the temperature survey are found in Appendix A of this report which was submitted and approved by the U.S. EPA before any fieldwork was started. The temperature tool calibration was confirmed by using a bucket test incorporating the use of both cold and hot water as well as a digital meter. This test is displayed at the beginning of the temperature log which can be found in Appendix F. The base temperature was run from surface down to 4510 feet.

4.2 Temperature Survey Results

The last two times that temperature surveys were run on Well #1-12 were December 4, 2012 and June 26, 2013. The data that was collected at that time was compared to the July 25, 2016 data and is displayed in the Table below.

WELL #1-12						
Depth	July 25, 2016	Gradient/ 1000'	December 4, 2012	Gradient/ 1000'	June 26, 2013	Gradient/ 1000'
100	54.6		51.0		53.5	
500	51.5	6.3	52.6	4.0	52.0	3.8
1000	54.0	5.0	55.3	5.4	54.7	5.4
1500	56.7	5.4	58.1	5.6	57.5	5.6
2000	59.3	5.2	60.6	5.0	60.0	5.0
2500	63.4	8.2	65.0	8.8	64.4	8.8
3000	71.0	15.2	74.1	18.2	73.5	18.2
3500	77.3	12.6	79.2	10.2	78.6	10.2
4000	81.7	8.8	83.2	8.0	82.8	8.4
4250	80.7	2.0	85.2	8.0	85.2	9.6
4500	87.5	13.6				

As can be seen in the table above, both the actual temperatures and calculated gradients obtained July 25, 2016 are consistent with images from the December 2012 and June 2013 logs. There are a few interpretations' that have to be made. First, the temperature at top of fluid for 2016 is higher which can be attributed to the actual top of fluid in the well over the past years. Another factor is the temperature of the thermister before it reaches the fluid. Secondly cooling start at 4025' and reaches its coolest at 4075', which can be expected due to cleaner rock at the bottom of the 7" casing. The fluid immediately heats up while going thru the shale at 4150'. The majority of the fluid is going into formation at 4325' finding clean rock again. This log confirms that there is no fluid movement upward out of the injection zone (3467').

5.0 RADIOACTIVE TRACER SURVEY

In order to verify that no fluid is moving upward around the casing shoe, a radioactive tracer log is run. Interpretation of the RTS indicates whether or not there is migration of injection fluids through channels in the cement sheath surrounding the protection casing.

This RTS is run by first recording a base gamma ray log over the interval of interest. Fluid is injected and a radioactive slug of Iodine 131 is released above the area to be tested. Fluid is injected and the progress of the slug monitored by repeatedly lowering the logging tool below the moving slug and logging upward through the slug. A second verification of the absence of upward fluid movement is obtained by releasing a slug of Iodine 131 above the area to be tested. The logging tool is set at the depth of interest and gamma radiation is recorded for approximately 30 minutes with the logging tool stationary. A final gamma ray survey is run to complete the logging procedure.

5.1 Radioactive Tracer Survey Procedure

The procedures for RAT were submitted to the EPA and can be found in Appendix A.

5.2 Results of the Radioactive Tracer Survey

An RTS was run between 4506 feet and 3063 feet injection Well #1-12 on August 8, 2016. The log can be found in Appendix G.

A. First Base Log: 4506 feet to 3063 feet

B. Five (5) minute statistical check at 3955 feet
Five (5) minute statistical check at 3802 feet

C. First radioactive slug ejected at 3750 feet.
Stationary time drive sequence
Fluid pump rate – 30-31 G PM
Injection pressure 326 psi

Bottom detector set at 4080 feet
Top detector set at 4075 feet
Monitored for 33 minutes

D. Second radioactive slug ejected at 3100 feet. The following table contains The depth of the top and bottom of each pass and the depth of the peak.

	START	STOP	PEAK DEPTH	FLOW GPM
1	3213	3188	3202	30
2	3328	3294	3314	30
3	3448	3406	3433	30
4	3603	3560	3585	30
5	3765	3708	3744	30
6	3936	3880	3916	30
7	4092	4030	4078	30
8	4160	4081	4115	30
9	4192	4100	4162	30
10	4255	4112	4233	30
11	4336	4284	4318	30
12	4363	4332	4354	30
13	4381	4363	4372	30

E. Final Base Log 4514 feet to 3055 feet

The radioactive tracer run in Well #1-12 on August 8, 2016 confirmed the leak-free condition of the tubing within the test interval as well as depicting that all injection fluids exited the injection tubing below the packer and moved out into the injection zone. The RTS verified that the cement at the top of the injection interval has integrity and there is no upward migration of injection fluids around the casing shoe.

6.0 AMBIENT PRESSURE MONITORING

In accordance with the United States Environmental Protection Agency's (U.S. EPA), requirements for the Class I UIC permit number MI-163-1W-CO10 granted to Environmental Geo-Technologies, LLC (EGT) and with the State of Michigan permit number M-452, a bottom hole pressure falloff test (Ambient Pressure Monitoring) was run on Well #1-12 to assist in evaluating the injection zone.

John Frost from EGT, Craig Merges from J.O. Well Service and Testing, and Richard Schildhouse from PB witnessed the Ambient Pressure Monitoring test which was run from August 9, 2016 to August 10, 2016.

6.1 AMBIENT PRESSURE MONITORING PROCEDURES

Procedures for performing the Ambient Pressure Monitoring were submitted to the regulatory agencies prior to doing any field work. A copy of those procedures can be found in Appendix A of this report.

6.2 AMBIENT PRESSURE MONITORING RESULTS

All depths in this report, unless otherwise noted, are referenced to the Kelly Bushing (KB) elevation which is 13 feet above the ground level elevation for Well #1-12. J.O. Well Services ran bottom-hole pressure gauges into Well #1-12 and set the gauges at 3950 feet KB on August 9, 2016.

Injection into Well #1-12 began at 07:24 AM on August 9, 2016 and continued until 08:33 PM on August 9, 2016, at which time Well #1-12 was shut in for the pressure falloff portion of the testing. The pressure falloff was monitored for approximately 9.75 hours. PB analyzed the test data with the assistance of the commercially available software program PanSystem3.4©. The PanSystem3.4© output for the analysis of this test is presented in Appendix B. J.O. Well Service and Testing, Inc.'s pressure test report and gauge calibration certificates are presented in Appendix C.

Table I lists general information as well as the reservoir characteristics for this well. Table II lists data pertinent to the current test. Table III lists the duration and final pressure measured during the pressure falloff test.

Figure 1 shows the bottom-hole pressure data that was recorded during both the injection and falloff periods of the testing on Well #1-12. It should be noted on Figure 1 the bottom-hole pressure began increasing approximately 1.677 hours following shut in. Radial flow developed at an elapsed time of 0.24 hours following shut in. Since radial flow developed prior to the pressure increase, a valid analysis of the pressure falloff data could be performed. Figure 2 is a Cartesian plot of the bottom-hole pressure data versus elapsed time recorded during the falloff period. The first step of the analysis consisted of generating a log-log diagnostic plot of Δp and the Δp derivative versus equivalent shut-in time (Figure 3) to determine the time at which radial flow begins. From the log-log diagnostic plot, radial flow begins at an elapsed time following shut in of 0.24 hours.

The formation mobility-thickness, kh/μ, was obtained from the slope of the line passing through the pressure data which occurred during the radial flow period (depicted in Figure 3) on the Horner semi-log plot (Figure 4). Figure 5 is an expanded view of Figure 4. The radial flow period begins at an elapsed Horner time following shut in of 1.84 and continues to the point where the bottom-hole pressure began increasing. The slope of the straight line passing through this region is 6.4274 psi/log cycle. The following equation is used to calculate mobility-thickness:

$$\frac{kh}{\mu} = 162.6\frac{qB}{m}$$

where:

kh/μ	=	mobility-thickness, md-ft/cp
162.6	=	constant
q	=	flow rate, barrels per day
m	=	slope of semi-log line, psi/log cycle
B	=	formation volume factor, reservoir volume/surface volume

Using the following values, the mobility-thickness is found to be 27,851 md-ft/cp:

q	=	31.45 gpm = 1090.23 barrels/day
m	=	6.4274 psi/log cycle
B	=	1.0 reservoir barrel/surface barrel

$$\frac{kh}{\mu} = 162.6\frac{(1090.23)(1.0)}{6.4274}$$

$$= 27{,}851 \text{md} - \text{ft/cp}$$

The permeability-thickness, kh, was determined to be 22,225 md-ft by multiplying the mobility-thickness, kh/μ, by the viscosity of the waste fluid of 0.798 centipoise:

$$kh = \left[\frac{kh}{\mu}\right]\mu$$

$$= (27{,}851)(0.798)$$

$$= 22{,}225 \text{ md-ft}$$

The formation permeability, k, was found to be 167.11 md using the formation thickness of 133 feet:

$$k = \frac{kh}{h}$$

$$= \frac{22{,}225}{133}$$

$$= 167.11 \text{md}$$

The following equation is used to calculate the formation skin factor:

$$s = 1.151\left[\frac{p_{wf} - p_{1hr}}{m} - \log\left(\frac{k}{\phi\mu c_t r_w^2}\right) + 3.23\right]$$

where:

s	=	formation skin factor, dimensionless
1.151	=	constant
p_{wf}	=	pressure immediately prior to shut-in, psia
p_{1hr}	=	pressure at a time of one-hour from the semi-log straight line, psia
m	=	slope of the semi-log straight line, psi/cycle
k	=	formation permeability, md
ϕ	=	formation porosity, fraction
μ	=	formation viscosity, centipoise
c_t	=	total compressibility of formation and fluid, psi^{-1}
r_w	=	wellbore radius, ft
3.23	=	constant

Using the following values, the skin factor is found to be 40.91

where:

p_{wf}	=	2045.21 psia
p_{1hr}	=	1777.31 psia
m	=	6.4274 psi/log cycle
k	=	167.11 md
ϕ	=	11%
μ	=	0.798 cp
c_t	=	6.2×10^{-6} psi^{-1}
r_w	=	0.3646 feet

$$s = 1.151\left[\frac{2045.21-1777.31}{6.4274} - \log\left(\frac{167.11}{(0.11)(0.798)(6.2\times10^{-6})(0.3646)^2}\right) + 3.23\right]$$

$$= 40.91$$

The change in pressure, Δp_{skin}, in the wellbore associated with the skin factor was determined to be 228.50 psi using the slope of the straight-line portion of the radial flow plot, the calculated skin factor, and the following equation:

$$\Delta p_{skin} = 0.869(m)(s)$$
$$\Delta p_{skin} = 0.869(6.4274)(40.91)$$
$$\Delta p_{skin} = 228.50 \text{ psi}$$

The flow efficiency (E) was determined from the following equation where:

$$E = \frac{p_{wf} - p^* - \Delta p_{skin}}{p_{wf} - p^*}$$

E	=	flow efficiency, fraction
p_{wf}	=	flowing pressure prior to shutting in the well for the falloff, 2045.21 psia
p^*	=	pressure extrapolated to an infinite shut-in time from the straight-line portion of the radial flow plot, 1769.88 psi
Δp_{skin}	=	pressure change due to skin damage, 228.50 psi

Substituting these values, the flow efficiency was calculated to be 0.17

$$E = \frac{2045.21 - 1769.88 - 228.50}{2045.21 - 1769.88}$$
$$= 0.17$$

A summary of the results of the pressure falloff analysis is presented in Table IV.

7.0 CONCLUSIONS

In conclusion, the Environmental Geo-Technologies, LLC Well #1-12 has displayed internal and external mechanical integrity. All procedures and evaluations have been done in accordance with state and federal requirements mandated in regard to U.S. EPA Permit MI-163-1W-C010 and Michigan Permit M-452.

- There is no significant leak in the casing, tubing or packer as evidenced by an annulus pressure test conducted on July 25, 2016.

- The temperature survey that was run on July 25, 2016 was comparable to the previous surveys conducted on December 4, 2012 and June 26, 2013. The 2016 survey displayed no indication of any fluid having an upward movement, thus confirming external integrity.

- The cement at the top of the injection interval and around the casing shoe has integrity. The survey that was run on August 8, 2016 indicated that all fluids left the injection string and entered into the formation and showed no indication of upward movements.

TABLE I

GENERAL WELL AND RESERVOIR INFORMATION

Date of Test	August 9 – 10, 2016
Wellbore Radius	0.3646 feet
Net Interval Thickness	133 feet
Average Historical Waste Fluid Viscosity	0.798 centipoise
Specific Gravity (estimated)	1.0
Porosity	11%
Total Compressibility	6.2×10^{-6} psi^{-1}
Formation Volume Factor	1 RB/STB

TABLE II

DATA SUMMARY FOR INJECTION PERIOD

Start Injection	August 9, 2016; 07:24 AM
Stop Injection	August 9, 2016: 08:33 PM
Time of Injection Period	13 hours
Test Fluid	Plant waste
Average Injection Rate	31.45 gpm (1090.23 bpd)
Pumps Used for Test	Plant Pumps
Final Injection Pressure	2045.21 psia
Gauge Depth Gauge Type/Serial No.	3590 feet KB PR-625/No. 9847
Gauge Sensitivity: resolution accuracy	0.15 psi 2.44 psi

TABLE III

DATA SUMMARY FOR FALLOFF PERIOD

Total Shut in Time	9.75 hours
Final Shut in Pressure	1775.96 psia

Does not agree with
data in Att. C p.7

TABLE IV

COMPARISON OF ANALYSIS RESULTS

Results From Log-Log and Horner Plots				
Parameter			Log-Log Plot Results	Superposition Plot Results
Wellbore Storage	C_s	bbls/psi	0.001	-
Mobility-Thickness	kh/μ	md-ft/cp	27,500	27,851
Permeability-Thickness	kh	md-ft	21,945	22,225
Permeability	k	md	165	167
Skin Factor	s	-	-	41
Pressure Drop due to Skin	$(\Delta p)_s$	psi	-	229
Flow Efficiency (Condition Ratio)	FE	-	-	0.17

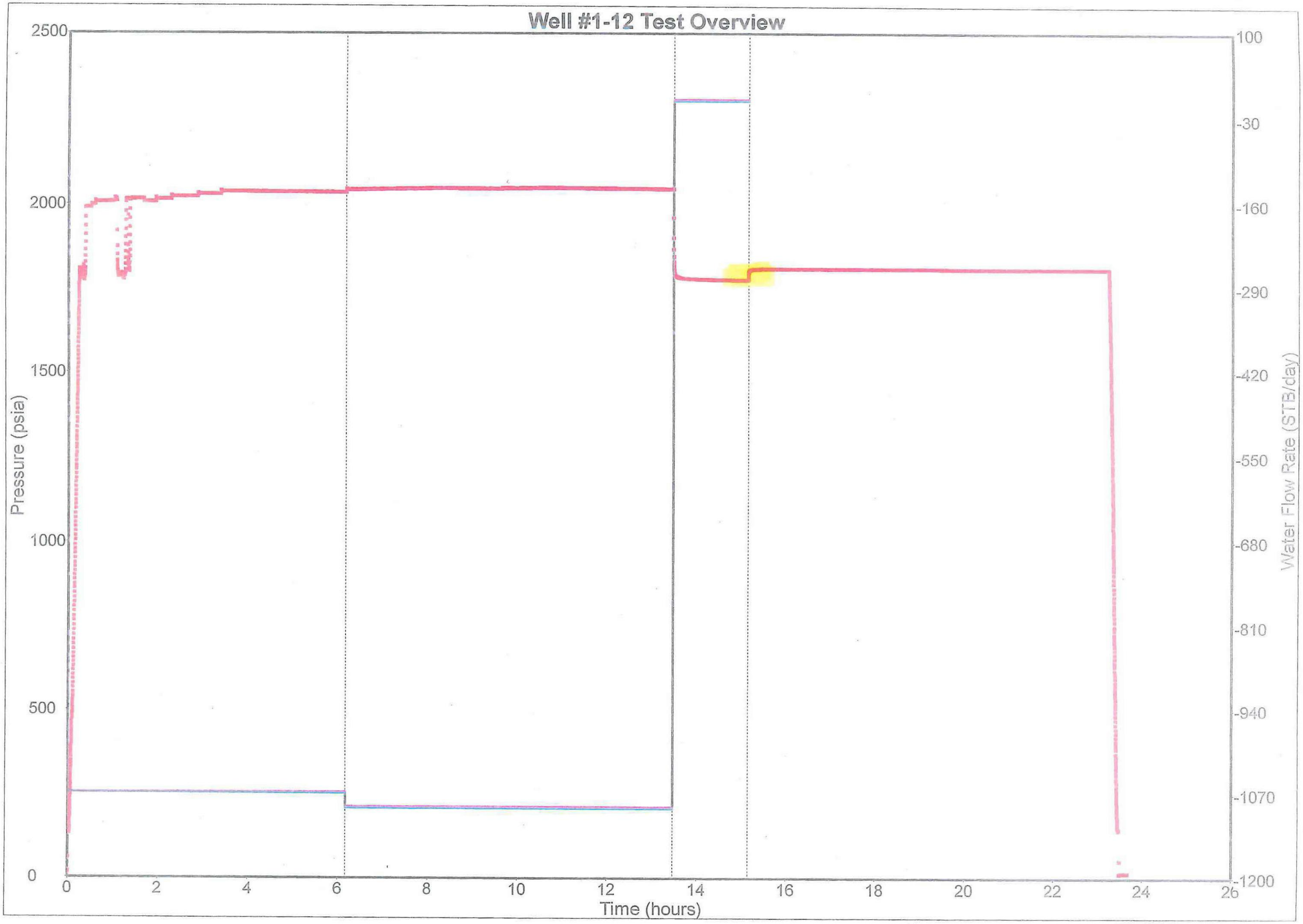
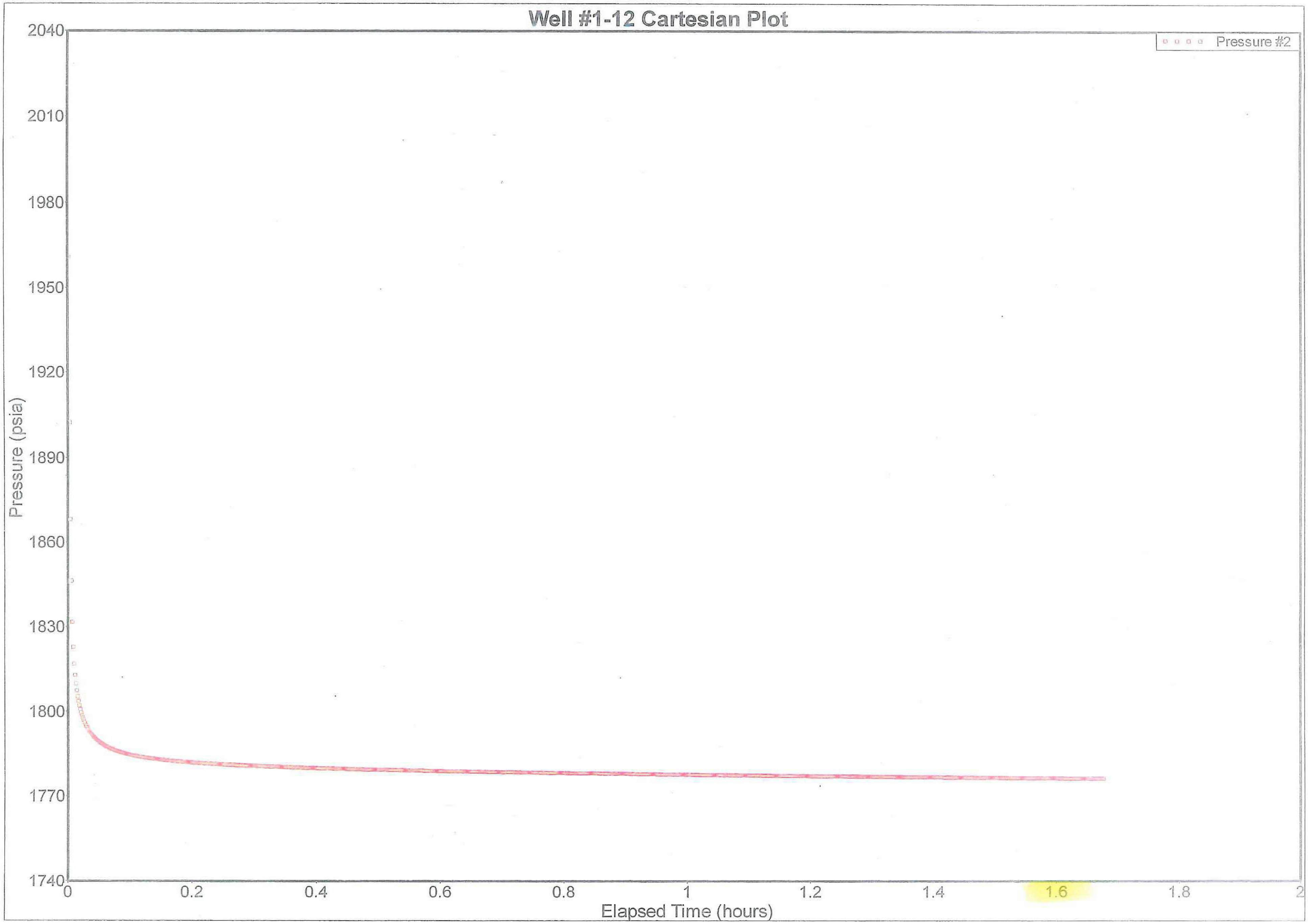
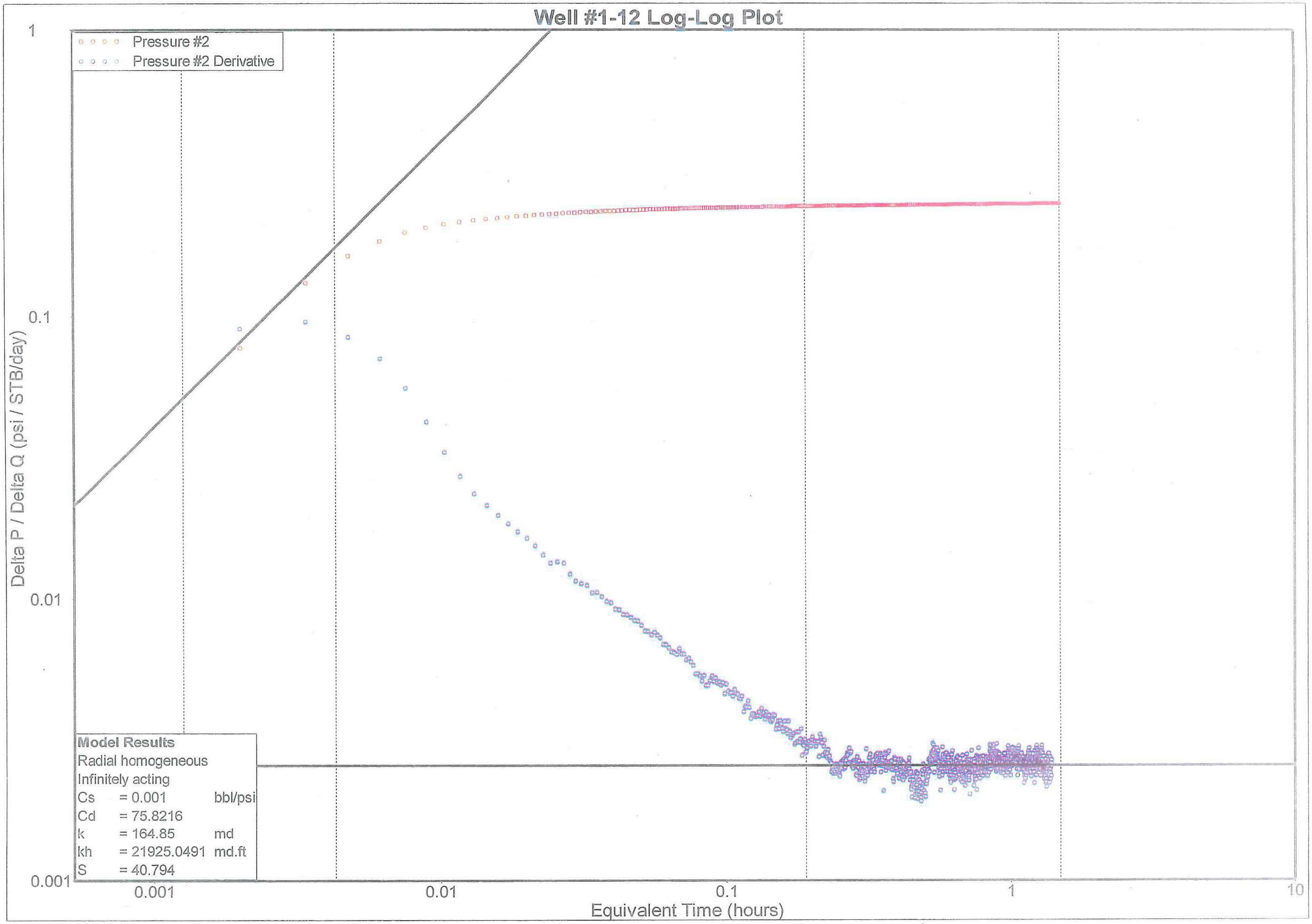

Well #1-12 Test Overview
Pressure (psia)
Water Flow Rate (STB/day)
Time (hours)
2500
2000
1500
1000
500
0
100
-30
-160
-290
-420
-550
-680
-810
-940
-1070
-1200
0
2
4
6
8
10
12
14
16
18
20
22
24
26

Figure 1



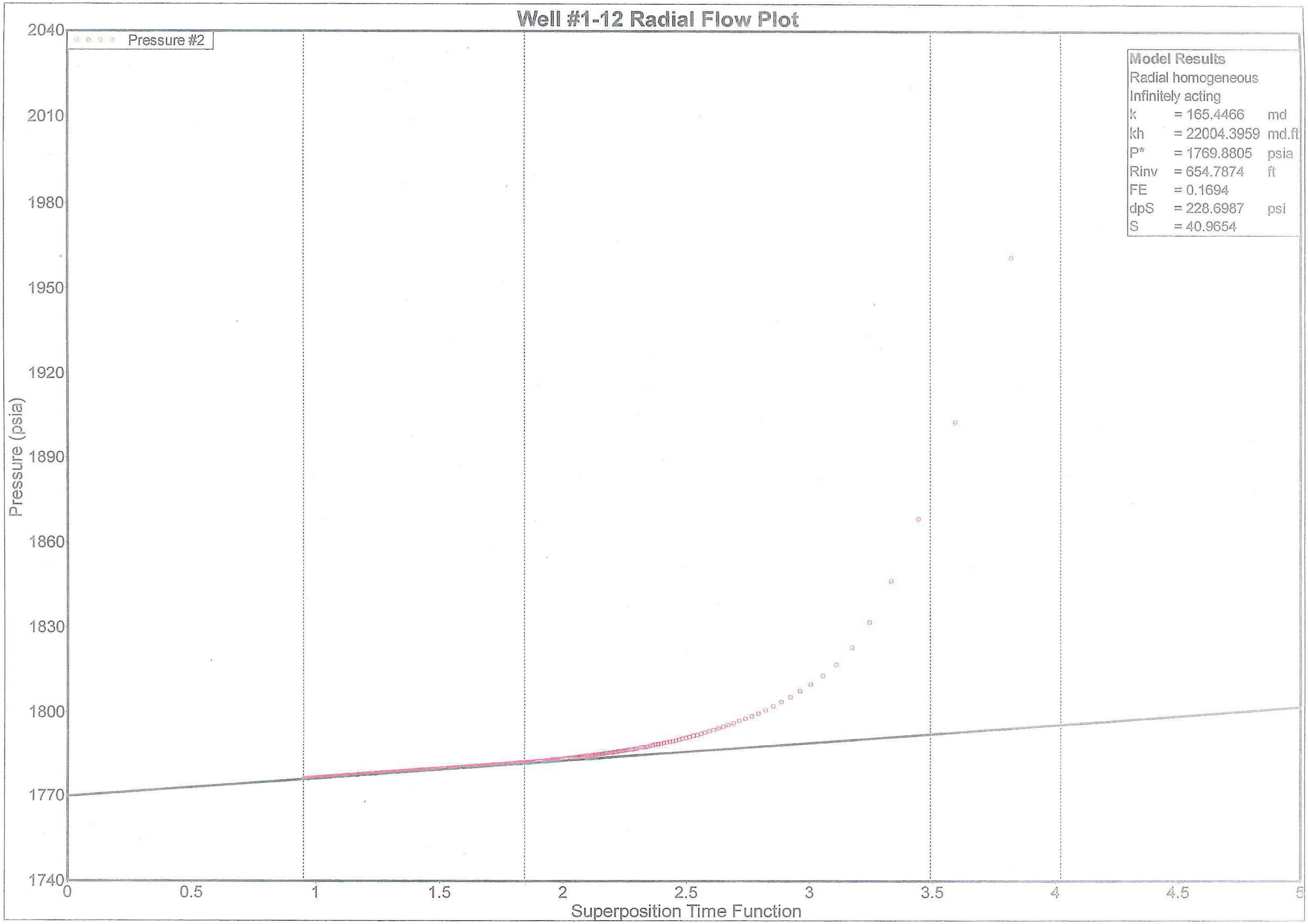
Well #1-12 Cartesian Plot
Pressure #2
Pressure (psia)
2040
2010
1980
1950
1920
1890
1860
1830
1800
1770
1740
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Elapsed Time (hours)

Figure 2



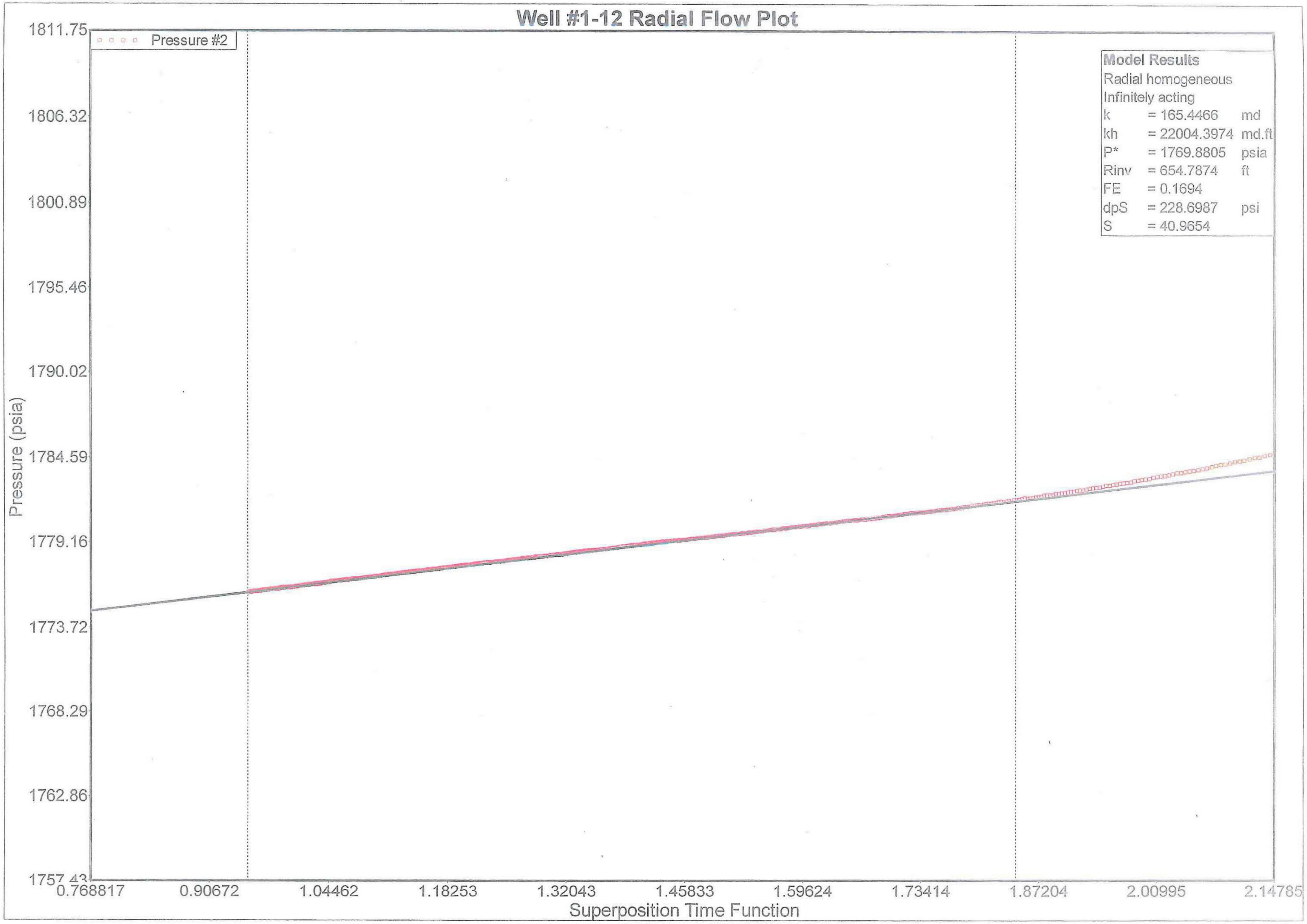
Well #1-12 Log-Log Plot
Pressure #2
Pressure #2 Derivative
Model Results
Radial homogeneous
Infinitely acting
Cs = 0.001 bbl/psi
Cd = 75.8216
k = 164.85 md
kh = 21925.0491 md.ft
S = 40.794
1
0.1
0.01
0.001
Delta P / Delta Q (psi / STB/day)
0.001
0.01
0.1
1
10
Equivalent Time (hours)

Figure 3



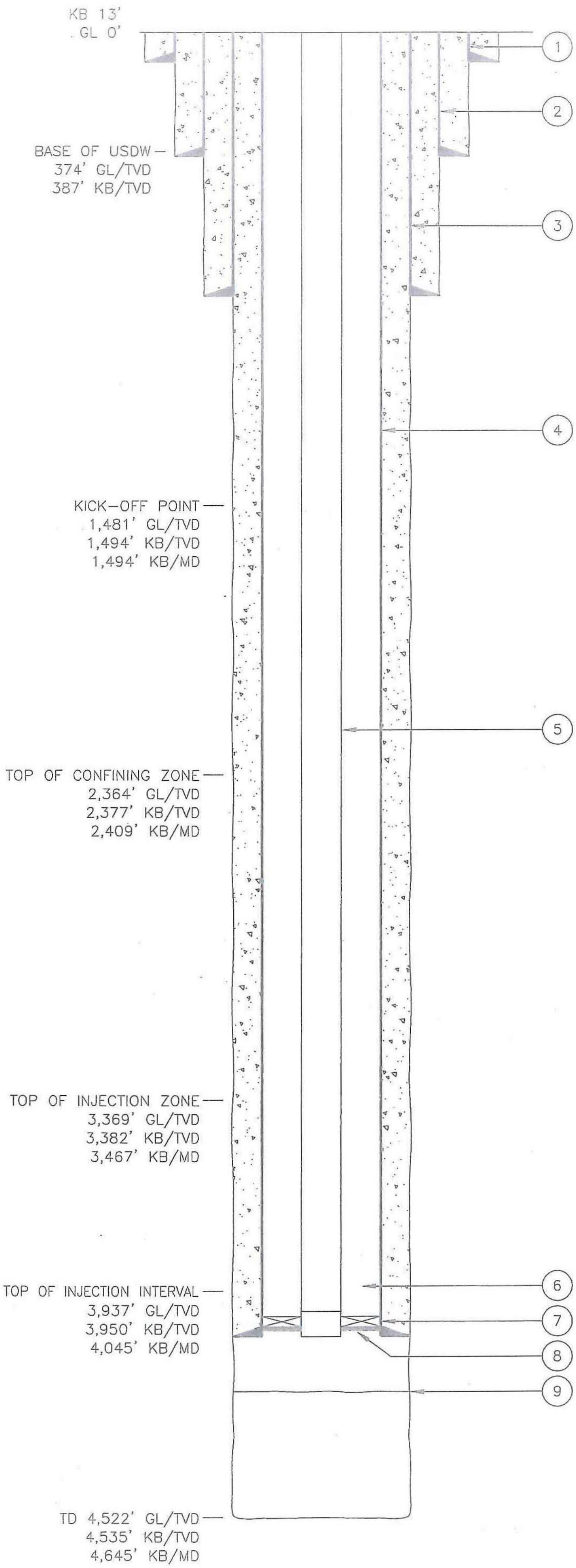
Well #1-12 Radial Flow Plot
Pressure #2
Model Results
Radial homogeneous
Infinitely acting
k = 165.4466 md
kh = 22004.3959 md.ft
P* = 1769.8805 psia
Rinv = 654.7874 ft
FE = 0.1694
dpS = 228.6987 psi
S = 40.9654
Pressure (psia)
2040
2010
1980
1950
1920
1890
1860
1830
1800
1770
1740
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Superposition Time Function

Figure 4



Well #1-12 Radial Flow Plot
Pressure #2
Model Results
Radial homogeneous
Infinitely acting
k = 165.4466 md
kh = 22004.3974 md.ft
P* = 1769.8805 psia
Rinv = 654.7874 ft
FE = 0.1694
dpS = 228.6987 psi
S = 40.9654
Pressure (psia)
1811.75
1806.32
1800.89
1795.46
1790.02
1784.59
1779.16
1773.72
1768.29
1762.86
1757.43
0.768817
0.90672
1.04462
1.18253
1.32043
1.45833
1.59624
1.73414
1.87204
2.00995
2.14785
Superposition Time Function

Figure 5



BELOW GROUND DETAILS

1. CONDUCTOR CASING: 20" O.D., 94 lb/ft, SET AT 119' KB/MD, 119' KB/TVD IN 24" HOLE AND CEMENTED TO SURFACE
2. SURFACE CASING: 13⅜" O.D., 48 lb/ft, H-40 SET AT 396' KB/MD, 396' KB/TVD IN 17½" HOLE AND CEMENTED TO SURFACE
3. INTERMEDIATE CASING: 9⅝" O.D., 36 lb/ft, J-55 SET AT 824' KB/MD, 824' KB/TVD IN 12¼" HOLE AND CEMENTED TO SURFACE
4. LONG STRING CASING: 7" O.D., 26 lb/ft, J-55 SET AT 4,080' KB/MD, 3,984' KB/TVD IN 8¾" HOLE AND CEMENTED TO SURFACE
5. INJECTION TUBING: 4-1/2" O.D. FIBERGLASS TO 4,050' KB/MD, 3,955' KB/TVD
6. ANNULUS FLUID: OIL BASED FLUID
7. PACKER AND SEAL ASSEMBLY: 4-1/2" X 7" GPS PACKER, TOP AT 4,050' KB/MD, 3,955' KB/TVD. BOTTOM AT 4,055' KB/MD, 3,960' KB/TVD
8. DIESEL PAD UNDER PACKER
9. TOP OF FILL AT 4,246' KB/MD, 4,147' KB/TVD

NOTE: TRUE BOTTOM OF WELL IS 211' SOUTH AND 754' WEST OF SURFACE LOCATIONS

NOTE: GROUND LEVEL ELEVATION 626.6'

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FIGURE 6
ENVIRONMENTAL GEO-TECHNOLOGIES, LLC
ROMULUS, MICHIGAN

EGT #1-12 WELL SCHEMATIC

DATE: 9/13/16	CHECKED BY: RWS	JOB NO: 50909A
DRAWN BY: CRB	APPROVED BY: RWS	DWG. NO:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

JUL 14 2016

REPLY TO THE ATTENTION OF:
WU-16J

CERTIFIED MAIL 7014 2870 0001 9579 6273
RETURN RECEIPT REQUESTED

Richard J. Powals
Vice-President
Environmental Geo-Technologies, LLC
28470 Citrin Drive
Romulus, Michigan 48174

Subject: Approval of Proposed Procedures for Testing in the Environmental Geo-Technologies #1-12 and #2-12 Wells, U.S. Environmental Protection Agency Underground Injection Control Permit #MI-163-1W-C010 and #MI-163-1W-C011, July 2016

Dear Mr. Powals:

The U.S. Environmental Protection Agency has reviewed and hereby approves the procedures proposed in your letter of June 20, 2016, for the testing referenced above with several conditions.

A copy of the pressure gauge calibration certificate for each gauge used during the testing (Standard Annulus Pressure Test and Ambient Reservoir Pressure Monitoring) should be submitted with your report.

I am enclosing information sheets for these tests. We request you fill in the blank cells and confirm the data in the gray cells and return the information sheets with the test results and interpretation, and up-to-date well schematics. This will help ensure that all the information we require for interpretation of the test will be included in your submission. Any anomalies in test results should be discussed. For example, both 2015 fall-off tests showed unusual behavior that was not initially discussed in EGT's reports. Note also that the differences between the two fall-off tests should be discussed. When reporting depths from the deviated well, please make it clear whether the depths are measured depths or true vertical depths, as appropriate. Please remember to submit the digital data either on CD or by email when you submit your report. Note that if the tests do not provide definitive information concerning the conditions which they are designed to ascertain, or approved procedures are not followed, you will be required to rerun them.

EPA cannot determine whether these tests will satisfy EGT's UIC permit requirements until the results have been submitted and analyzed. All mechanical integrity tests must be approved by the Director, which can only be done after the test results have been reviewed. The procedures you submitted should provide acceptable results, if the tests are properly conducted and the results properly interpreted.

It is our practice that testing be witnessed by an EPA staff member or our contract field inspector to the extent possible. Please contact Jeff McDonald at (312) 353-6288 to schedule the witnessing of these tests. Unwitnessed tests are only acceptable if it is impossible for an EPA staff member or the field inspector to be present.

If you have any questions about this letter or if you find during the test that you are unable to follow the approved procedures, please contact Stephen Roy of my staff by phone at (312) 886-6556 or by email to roy.stephen@epa.gov.

Sincerely,

Stephen M. Jann, Chief
Underground Injection Control Branch

Enclosures

cc: Sam Williams (email only with procedure)
Ray Vugrinovich, Michigan Department of Environmental Quality (email letter only)
Rich Schildhouse, WSP | Parsons Brinckerhoff (email only)

BACKGROUND INFORMATION FOR REVIEW OF RADIOACTIVE TRACER SURVEYS FOR CEMENT INTEGRITY

Facility Name: Romulus Facility			Operator: Environmental Geo-Technologies		
Well Name: Well 1-12			USEPA Permit Number: MI-163-1W-C010	Witness: 0	
State: Michigan	Test Date: 8-8-16		Logging Company: MICHIGAN WIRELINE		

Well and Operational Information

Long String Csg Material: Steel and Hastelloy	Long String Casing OD: 7	Casing weight, #/ft: 26	Casing ID, ins: 6.276	Long String Casing Length, ft: 4080	
Tubing Material: Fiberglass	Tubing OD, ins: 4.5		Tubing ID, ins: #N/A	Tubing Length, ft: 4050	
Tail Pipe Material: 0	Tail Pipe OD, ins: 0	Tail Pipe, weight#/ft: 0	Tail Pipe ID, ins: 0	Tail Pipe Length, ft: 0	Tail Pipe Depth: 4055
	Open Hole diameter, in: 8.75	TD, ft: 4645	PBTD, ft: 4246	Top of Open Interval, ft: 4080	
Packer Model: GPS	Packer Type	Top of Packer, ft: 4050	Bottom of Packer, ft: 4055		

Geological Information

Lowermost USDW Name: Dundee Limestone	Fms in Arrestment Interval: Utica Shale and Trenton Limestone	Fms in Injection Interval: Franconia, Eau Claire, Mt. Simon
Base of USDW, ft: 387	Depth to top of Arrestment Interval, ft: 2409	Injection Interval Top, ft: 4045

TOOL INFORMATION

Ejector, ft above BDET: 9'	TDET, ft above BDET: 5'	MDET, ft above BDET			

CALIBRATION INFORMATION

Depth BDET, ft	Depth TDET, ft	BDET CPSPI	Shaly zone: 3802	Maximum Reading, LD	Minimum Reading, LD
Depth BDET, ft	Depth TDET, ft	BDET CPSPI	Clean zone: 3955	Maximum Reading, LD	Minimum Reading, LD

BACKGROUND LOG (BDET) BEFORE TESTS

Appearance of Log, lithology discernible, extremely suppressed, noisy, etc. Is calibration the same as for statistical checks?

FIRST SLUG TRACKING SEQUENCE

Flow Rate, gpm	Velocity in tubing, fps	Depth of deflection on	Deflection on 1st pass	Deflection/Background	Passes Through Slug
Slug Split? yes or no	Depth of Split, ft	Moved up, yes or no	Minimum Slug Depth,	Distance above shoe,	Maximum Slug Depth, ft

FIRST STATIONARY TEST

Depth of BDET, ft	Depth of TDET, ft	BDET to open interval	Time at station, mins	Injection Rate, gpm	Log Divisions per Minute
Depth at Injection, ft		BDET above end of tubing or casing, ft	Reached BDET up, LD	Reach UDET up, LD	Velocity Up, ft/min
2nd Setting Depth, ft	Time of reset	Slug already passed BDET?	Reached BDET up, LD	Slug arrival time	
3rd Setting Depth	Time of reset	Slug already passed BDET?	Reached BDET up, LD	Slug arrival time	
4th setting depth, ft	Time of reset	Slug already passed BDET?	Reached BDET up, LD	Slug arrival time	Upper Limit of Movement, ft

BACKGROUND INFORMATION FOR ANALYSIS OF PRESSURE FALL-OFF TEST

FACILITY NAME		OPERATOR	
Romulus Facility		Environmental Geo-Technologies	
WELL NAME		USEPA PERMIT NUMBER	STATE PERMIT NUMBER
Well 1-12		MI-163-1W-C010	M-452
TEST DATE			
8-9-16 & 8-10-16			

GEOLOGICAL DATA

POROSITY, decimal	NET PERMEABLE THICKNESS, ft.	VISCOSITY, cp.	COMPRESSIBILITY, per psi
0.11	133	1.22	6.20E-06

WELL AND OPERATION DATA

WELL RADIUS, ins	PRETEST FLOW RATE, gpm	INJECTATE TEMPERATURE, deg.F	KB ELEVATION, ft
4.375			626.6
GAUGE DEPTH, ft	PRETEST FLOW TIME, hrs.	INJECTATE SPECIFIC GRAVITY	TEST DEPTH FOR COMPARISON, ft
3950		1.0	
CUMULATIVE VOLUME INJECTED SINCE LAST PRESSURE EQUALIZATION, gallons			

TEST DATA

GAUGE CALIBRATION DATE			
6-9-2016			
FLOW RATE, gpm	INITIAL PRESSURE, psi	FINAL PRESSURE, psi	TO SUPPORT FULL COLUMN, psi
30-31	1793	1793	
TEST LENGTH, hrs.	INITIAL GRADIENT, psi/ft.	FINAL GRADIENT, psi/ft.	FINAL FLUID LEVEL, ft.
22.75			

REMEMBER

1. Injection of normal injectate at normal rate is preferred.
2. Please compare data in your records to that in the gray cells above. If there is a difference, be sure the correct information is noted. Please fill in the information in the other cells.
3. Please submit an up-to-date well schematic
4. Data should be collected at the maximum rate for at least the first five minutes; between five and thirty minutes at no less than one reading every 30 seconds. After thirty minutes, the operator can reduce frequency as required.

BACKGROUND INFORMATION FOR REVIEW OF TEMPERATURE LOGS

Facility Name		Operator	
Romulus Facility		Environmental GeoTechnologies, Inc.	
Well Name		**USEPA Permit Number**	
Well #1-12		MI-163-1W-C010	
County	**State**	**Test Date**	
Wayne	Michigan	7-25-16	

Well and Operational Information

Top of Open Interval, ft	Tubing Depth, ft	Date of Last Injection	Is This a Multi-Zone Facility?
4080	4050	7-23-16	
Depth to Base of USDW, ft.	**Name of lowermost USDW**	**Hour of Last Injection**	**Other Zones Used at Facility**
387	Dundee Limestone		
Depth to Top of Permitted Int, ft	**Name of Injection Interval**	**Volume Injected in Past Year, gal**	**Name of Shallower Injection Zone**
3467	Trempealeau, Franconia,		
Plugged Back Depth, ft.	**Total Depth, ft**	**Injectate Temperature Variance, °F**	**Depth to Shallower Injection Zone, ft**
	4645		

Calibration Information		Logging Information	
Low Gauge Temperature, °F	**High Gauge Temperature, °F**	**Time of Start of Logging**	
55.8	108.0		
Low Thermometer Temperature, °F	**High Thermometer Temperature, °F**	**Days Since Last Injection**	**Maximum Log Depth, ft.**
56.0	108.6	2	4510
Were Log Readings Adjusted?	**Gauge Calibration Date**	**Multiple Log Runs?**	**Maximum Logging Speed, ft/min**
NO		YES ??	30

REMEMBER

1. Well should have been shut in for at least 36 hours.
2. If well cannot be shut in for 36 hours, shut in as long as possible and run two logs at least six (6) hours apart
3. Record log data at one measurement per foot.
4. Record natural gamma ray activity log with temperature.
5. Log top to bottom. Keep logging speed below 30 feet per minute.
6. Log quality in air-filled holes can be improved by logging at a slower speed. Please reduce logging speed to less than 20 feet per minute in the top 1000 feet of air-filled holes.
7. Please compare data in your records to that in the cells above. If there is a difference, be sure the correct information is noted. Please fill in the other cells.
8. Submit digital logging data on a CD in .las or .asc format
9. Please submit an up-to-date well schematic